

ECOLOGY OF THE WEST INDIAN RED-BELLIED WOODPECKER ON GRAND CAYMAN: DISTRIBUTION AND FORAGING

ALEXANDER CRUZ AND DAVID W. JOHNSTON

The West Indian Red-bellied Woodpecker (*Melanerpes superciliaris*) is widely distributed in the West Indian region, occurring on Cuba, Isle of Pines, Grand Cayman, Grand Bahama, Abaco, and San Salvador (Watling's) Island. Because of its extensive distribution in contrast to other Antillean woodpeckers (Bond 1956, Cruz 1974), *M. superciliaris* is an exceptionally good species for studies of geographic variation in foraging behavior, in differential sexual foraging related to regional variation in quality and quantity of food, and in intensity of interactions with other woodpeckers and species of similar foraging adaptations. To date, *M. superciliaris* remains little known; the primary literature, with the exception of the Grand Cayman subspecies (*M. s. caymanensis*), consists almost entirely of brief accounts (Gundlach 1893, Allen 1905, Bangs and Zappey 1905, Riley 1905, Barbour 1923, Paulson 1966, Brudenell-Bruce 1975, Garrido and Garcia Montaña 1975, Miller 1978, King 1981). Johnston (1970, 1975) and Cruz and Johnston (1979) summarized aspects of the ecology of *M. superciliaris* on Grand Cayman, and Cruz (1974) discussed the probable evolution and fossil record of *M. superciliaris*.

The present study of *M. superciliaris* was initiated on Grand Cayman in 1965 and continued intermittently until 1974, covering all seasons. A total of 800 h was spent in the field. The objectives of these investigations were to obtain data on: (1) distribution and habitat preferences, (2) food and foraging ecology, and (3) differential feeding between the sexes.

STUDY AREAS

Grand Cayman lies approximately 290 km south of Cuba, 310 km west of Jamaica, and 480 km NE of Honduras, the nearest point in Central America. Much of Grand Cayman (185 km²) is less than 5 m above sea level. Temperatures are fairly constant (mean annual high 30°C) and annual mean precipitation is 1549 mm (Johnston 1975). A dry season extends from November to April. To obtain as complete a picture as possible of the ecology of *M. superciliaris*, we visited many distinct habitats (strand woodland or sea grape-almond woodland, mangrove woodland, open pastures, scrub woodland, limestone forest, and town and house sites). Scrub woodland consists of abandoned and other cleared areas that revert to woods consisting of species such as maiden plum (*Comocladia pinnatifolia*), red birch (*Bursera simaruba*), and logwood (*Haematoxylum campechianum*). Open and, later, dense stands of nearly pure logwood develop on drier upland sites. Older stages frequently include thatch palm (*Thrinax argentea*) and red birch (logwood-thatch palm-red birch association). The woodland averages about 6 m in height. Investigations were done in the logwood forest

and in the logwood-thatch palm-red birch association. For a more detailed description of these areas see Johnston (1975) and Cruz and Johnston (1979).

METHODS

Population density.—Traditional techniques for measuring bird populations, such as transect counts or territory mapping, proved to be impossible in the rough and uneven terrain of Grand Cayman. The absence of trails for accurately measuring distances in most of the woods made it difficult to measure population densities precisely. A semi-quantitative method was devised to provide relative indices of abundance. Ten censuses, each about 2-h long, were taken in the early morning in representatives of each of the major ecological formations during December, April, May, June, and August of all years. After all birds recorded during each census were counted, relative abundance scores were derived as follows: U (uncommon), 5–20 individuals/20 h; FC (fairly common), 20–100 individuals/20 h; C (common), 100–200 individuals/20 h.

Foraging ecology.—Habitat use, foraging, and feeding methods of the birds in the study areas were studied by adapting methods used by MacArthur (1958), Cody (1974), and Cruz (1977). We moved about the study areas on a systematic basis, observing as many different birds at various times of the day as possible. Individuals were followed as long as they remained in sight, which in some of the stands was not usually longer than 60 sec. In some cases, however, birds were observed for several minutes and a sequence of foraging maneuvers was obtained. An individual observation was terminated if the bird changed behavior. A Chi-square contingency test was used to evaluate the frequency of occurrence in each of the categories. Only differences at the $P < 0.05$ level of significance were accepted.

We calculated overlap in foraging behavior of males and females with Schoener's (1970) equation:

$$\% \text{ overlap} = 100 [1 - 0.5 \Sigma (P_{x,i} - P_{y,i})]$$

where $P_{x,i}$ and $P_{y,i}$ are the respective frequencies for males and females in each class for a given type of behavior. An overlap of 100% indicates that the sexes acted identically in regard to the type of behavior examined, whereas 0% overlap indicates completely different behavior.

Foods.—We collected 14 adults on Grand Cayman for stomach analyses. The stomach and intestinal tract were removed soon after death and preserved in 75% alcohol. Later the foods therein were separated taxonomically and analyzed by volume and by frequency of occurrence. Food volumes were ascertained with reasonable accuracy by noting the displacement of water in a graduated cylinder accurate to 0.1 ml. Whole invertebrates were identified at least to family; fragmented insects were identified to order in nearly all cases and often to family. Similar methods were used to identify fruits found in the stomach.

Body measurements.—Morphological data were obtained by standard mensural methods to see if any sexual dimorphism in body structures of possible ecological significance existed. Bill length was measured from the anterior margin of the nostril to the tip; the tarsometatarsus was measured from its posterior proximal end to the distal edge of the most distal unbroken scale crossing the bases of the two forward toes. Measurements were done to the nearest 0.1 mm with vernier calipers. We weighed all the specimens to the nearest 0.1 g with a triple beam balance.

RESULTS

Habitat, distribution and abundance.—*M. superciliaris* occurred over the island in all forests, from mangrove woodlands to dense limestone

TABLE 1
RELATIVE ABUNDANCE^a OF *MELANERPES SUPERCILIARIS* IN VARIOUS HABITATS ON GRAND
CAYMAN

Habitat	December	April-May	June	July
Strand woodland ^b	NO	NC	U	NO
Mangrove swamps	U	NC	NO	U
Logwood forests	U	NC	U	NC
Scrub forests ^c	U	FC	NC	FC
Limestone forests	C	FC	NC	FC
Town and house sites	U	U	NC	U

^a NO = not observed, NC = not censused, U = uncommon (5-20 individuals 20 h), FC = fairly common (20-100 individuals 20 h), C = common (100-300 individuals 20 h).

^b Also called sea grape-almond woodland.

^c Logwood and logwood-thatch palm-red birch associations.

forest. The birds were most numerous in the limestone forests and scarcest in the mangrove and ruderal sites (Table 1). *M. superciliaris* occurred in habitats where the diversity of tree species ranged from low (one or two species), such as mangrove and logwood forests, to high (10-15 species), such as limestone forests. The birds were absent from pastures and cultivated areas, despite scattered trees.

Measurements.—Besides the sexual differences in degree of redness of the head region (crown to hindneck scarlet in male, but only nape and hindneck red in female), the mean values for weight, culmen, and tarsometatarsal length were found to be greater in males than in females (Table 2). The overall variation for bill length was slightly greater among females and for tarsometatarsal length among males (Table 2). Weights varied more in males than females. Despite the overlapping ranges found for all the parameters measured, the intersexual differences between the mean values were significant at $P < 0.001$ level for culmen length ($t = 5.66$, $df = 21$), weight ($t = 3.70$, $df = 14$), and tarsometatarsal length ($t = 2.98$, $df = 19$).

The degree of intersexual difference (expressed as the difference in mean values in relation to the mean values for males) in bill length and in weight was greater than that found for tarsometatarsal lengths (Table 2). The greater degree of sexual dimorphism found in bill length and in weight is emphasized by the coefficient of difference (derived from the mean difference between the sexes divided by their combined standard deviations) and the corresponding joint non-overlap values (Dunn and Everitt 1982) which indicates the proportion of the individuals of each sex which does not overlap a corresponding proportion of those of the other sex. The coefficients indicate a 91% joint non-overlap for bill length (C.D. = 1.35)

TABLE 2
 MEAN WEIGHTS AND MEASUREMENTS OF *MELANERPES SUPERCILIARIS CAYMANENSIS*^a

	Males		Females		C.V. ^b	% difference in mean measurements	Coefficient of difference	% joint nonoverlap
	N	Mean ± SE (range)	N	Mean ± SE (range)				
Bill (mm)	17	26.4 ± 0.30 (23.5–28.0)	6	23.2 ± 0.5 (21.7–24.5)	5.24	12.1	1.35	91
Tarsus (mm)	16	23.97 ± 0.28 (21.8–26.1)	5	22.4 ± 0.44 (21.0–23.1)	3.9	6.5	0.81	77
Weight (g)	11	84.2 ± 2.5 (71.3–99.3)	5	71.0 ± 1.49 (67.3–73.5)	4.2	15.7	1.21	89

^a Data from Ridgway (1914) and this study.

^b Coefficient of variation.

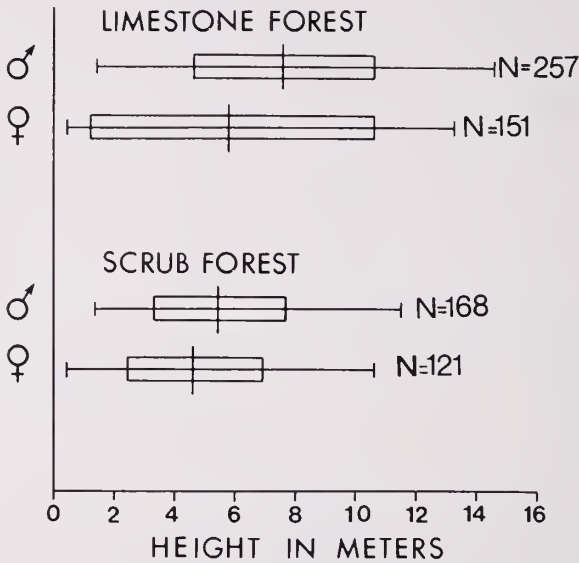


FIG. 1. Foraging heights of male and female *Melanerpes superciliaris*. Open rectangles represent 1 SD to either side of the mean; the line indicates the range.

and an 89% of joint non-overlap in weight (C.D. = 1.213) for *M. s. caymanensis* (Table 2).

Foraging heights.—Detailed foraging ecology information was obtained in two distinct habitats—scrub forest (average tree height 6 m) and dry limestone forest (average tree height 9 m). In general, males foraged significantly higher than females ($P < 0.05$). In the scrub forest the mean foraging heights for males and females were 5.39 and 4.49 m ($t = 3.3$, $df = 287$), respectively, and in the limestone forest the mean foraging heights for males and females were 7.69 and 5.83 ($t = 4.96$, $df = 406$), respectively (Fig. 1). Overlaps in use of foraging heights by the sexes were 80.4% and 90.9%, respectively, for the scrub and limestone forests. Both sexes used similar foraging heights, but at different frequencies.

Foraging zones.—Table 3 summarizes the pooled results for the scrub and limestone forests of the total number of times *M. superciliaris* was noted in the different foraging zones—trunk, inner, and outer portions of the crown. *M. superciliaris* used different zones preferentially, but with the exception of the lower trunk, no statistically significant intersexual differences in the use of these zones (Chi-square contingency tests) were noted (Table 3). The inner branches were most commonly used as a foraging zone with the trunks being used the least. Although both sexes

TABLE 3
FORAGING ZONES OF *MELANERPES SUPERCILIARIS* ON GRAND CAYMAN

Habitat	Tree zone	Percent use		Percent difference
		Male	Female	
Pooled data		421 ^a	272	
from scrub	Trunk			
and limestone	lower	8.2	13.4	5.2 ^b
forests	upper	6.8	7.3	0.5
	Branches			
	inner	47.05	42.2	4.9
	outer	38.00	37.3	0.7

^a Number of observations.

^b Chi-square values: lower trunk ($\chi^2 = 4.32$, $df = 1$, $P < 0.05$), upper trunk ($\chi^2 = 0.16$, $df = 1$, NS), inner branches ($\chi^2 = 1.37$, $df = 1$, NS), outer branches ($\chi^2 = 0.01$, $df = 1$, NS).

used the lower trunk, females tended to use this zone significantly more, 13.4% vs 8.2%, respectively (Table 3). Overlaps in the use of zones by the sexes was 94.5%.

Foraging behavior.—The pooled results for both sexes from both study areas indicate that the predominant foraging methods are fruit-eating (37.7%), arboreal gleaning (23.9%), probing (20.6%), and pecking (13.4%). Probing into epiphytes accounted for the rest of the foraging methods (Table 4). Males pecked more frequently than females, and females gleaned more frequently. These differences were statistically significant (Chi-square contingency tests). Overlap in use of methods by the sexes was 84.6%, however, differences in frequencies of use of probing, fruit-eating, and epiphytic probing were not statistically significant (Table 4).

In probing, both the bill and the tongue were used to explore natural cavities and accumulations of plant materials. Cavities in which the woodpeckers probed included fissures and cracks in the bark, knot holes, weathered holes previously excavated by woodpeckers, holes in ends of rotten or dying branches, and stumps. Accumulation of plant material included debris between trunks and lateral trunks. Pecking for food was confined mainly to dead or dying portions of the tree, ranging from large trunks to the outer branches. In pecking, *M. superciliaris* assumes the woodpecker stance described by Spring (1965) for some North American woodpeckers. The whole body is held away from the tree trunk and the blow delivery momentum appears to come from regions posterior to the neck, although it appears that the neck also plays a role. Gleaning consisted in search along the limb and trunk surfaces for invertebrates and use of the tongue to capture prey.

TABLE 4
FORAGING BEHAVIOR OF *MELANERPES SUPERCILIARIS* ON GRAND CAYMAN

Habitat	Method	Percent use		Percent difference
		Male 421 ^a	Female 272	
Pooled data from scrub and limestone forests	Pecking	19.4	7.3	12.1 ^b
	Probing	20.9	20.3	0.6
	Gleaning	17.4	30.5	13.1
	Fruits	39.1	36.3	2.8
	Epiphytes	3.3	5.7	2.4

^a Number of observations.

^b Chi-square values: pecking ($\chi^2 = 14.2$, $df = 1$, $P < 0.001$), probing ($\chi^2 = 0.008$, $df = 1$, NS), gleaning ($\chi^2 = 15.5$, $df = 1$, $P < 0.001$), fruits ($\chi^2 = 0.42$, $df = 1$, NS), epiphytes ($\chi^2 = 1.5$, $df = 1$, NS).

Although *M. superciliaris* is structurally specialized to obtain food by pecking, fruit-eating constitutes a greater proportion of the pooled foraging behavior than pecking, the former accounting for 37.7% and the latter for 13.4%. In addition, the results of the stomach analyses indicate an even greater use of fruits (Table 5) than shown by the foraging behavior. *M. superciliaris* showed considerable agility in moving over the outer branches of trees where most of the fruits grew. Birds often balanced between two limbs, with legs spread apart, holding one branch with each foot, and reaching out for the fruits. Sometimes individuals flew to a clump, clung to the fruits, and plucked them. Small fruits (<30 mm) were plucked and swallowed, and if the fruits were small (10 mm) it was not uncommon to see woodpeckers with more than one fruit in the bill at a time. If the fruit was large (>30 mm) (e.g., papaya), the bird first pecked a hole in it and then used the bill and tongue to probe and feed on the fleshy pulp. We recorded 11 different species of fruits eaten by *M. superciliaris*. Fruits from trees of the families Caricaceae, Moraceae, and Burseraceae figured prominently.

Stomach analyses.—The stomach content overlap indices (93%), calculated on frequency of families in the diet, suggest that males and females took similar food items. Therefore, the diets of males and females were combined in the analysis of diet (Table 5). Evidence of differential food-size selection was not found. In *M. superciliaris* diets, both animal and vegetable matter are well represented, comprising 56.0% and 44.0%, respectively, of the total volume, and 64.3% and 78.6%, respectively, of the percent occurrence (Table 5). A striking general result of the present study is the demonstration of the major role played by vegetable material

TABLE 5
FOOD ITEMS FOUND IN THE STOMACHS OF *MELANERPES SUPERCILIARIS*

	Percent (14)*			Percent (14)*	
	Occurrence	Volume		Occurrence	Volume
Mollusca	7.1	1.8	Plantae		
Gastropoda	7.1	1.8	Moraceae	21.4	7.2
Pulmonata	7.1	1.8	<i>Ficus</i>	21.4	7.2
Arthropoda	64.3	46.7	Myrtaceae	7.1	1.3
Arachnida	14.3	2.2	<i>Eugenia</i>	7.1	1.3
Araneidae	14.3	2.2	Caricaceae	57.1	29.3
Insecta	64.3	44.5	<i>Carica</i>	57.1	29.3
Orthoptera	35.7	31.5	<i>Burseraceae</i>	14.3	4.1
Gryllidae	28.6	21.0	<i>Bursera</i>	14.3	4.1
Acrididae	21.4	10.5	Passifloraceae	2.1	2.1
Coleoptera	21.4	5.8	<i>Passiflora</i>	2.1	2.1
Curculionidae	7.1	2.2			
Tenebrionidae	7.1	3.6			
Hymenoptera	14.3	4.2			
Formicidae	7.1	3.1			
Vespidae	7.1	1.1			
Vertebrata	14.3	7.5			
Amphibia	7.1	3.3			
Hylidae	7.1	3.3			
Reptilia	14.3	4.2			
Gekkonidae	7.1	4.2			
Total	64.3	56.0		78.6	44.0

* Sample size of stomachs.

(fruits) in the diet of a member of a family considered to be primarily insectivorous.

The animal food embraced 5 classes, 7 orders, and 10 families. Insects were most important in the woodpecker diet, comprising 44.5% by total volume. The most important insect taxa were orthoptera, accounting for 31.5% of the total volume. The proportion of prey found in the stomachs (56.0%) is in close agreement with observations of foraging methods, where gleaning, probing, and pecking for prey accounted for 57.6% of the total pooled foraging. Plant materials consisted of fruits and seeds representing four identified families and four genera. The family Caricaceae was the most important in the diet, their pulp and seeds accounting for 29.3% of the total volume. Other plants important in the diet (in percent

of total volume) were fruits and seeds of the families Moraceae (7.2%) and Burseraceae (4.1%).

DISCUSSION AND CONCLUSIONS

Among woodpeckers, in general, females tend to be smaller than males in several mensural characteristics (Selander and Giller 1963, Selander 1966). Selander and Giller (1963) found that the degree of sexual dimorphism in culmen length of some *Melanerpes* woodpeckers is greater than any other morphological characteristic compared—this was especially true in some West Indian forms, e.g., Hispaniolan Woodpecker (*M. striatus*) of Hispaniola, Guadeloupe Woodpecker (*M. herminieri*) of Guadeloupe, and the Puerto Rican Woodpecker (*M. portoricensis*) of Puerto Rico. The proposal of Selander and Giller (1963), that this disproportionate degree of sexual dimorphism in culmen length is adaptive and serves to alleviate intersexual competition for food, was later confirmed by Selander (1966) for *M. striatus* and by Wallace (1974) for *M. striatus* and *M. portoricensis*. Subsequently, various investigators have quantified foraging differences between the sexes in woodpeckers (Kilham 1965, 1970; Ligon 1968a, b; Jackson 1970; Koch et al. 1970; Short 1970a, b; Willson 1971; Kisiel 1972; Austin 1976; Hogstad 1976, 1978; Jenkins 1979; Winkler 1979; Ramey 1980; Williams 1980; Hooper and Lennartz 1981). The sexes may forage in different strata, use different foraging techniques, or take food items of different sizes.

When the differences found in those morphological characters that are important for feeding (e.g., bill size) in *M. superciliaris* are compared with the intersexual differences in foraging behavior, a relationship between dimorphism and feeding niches seems evident. Compared with the female, the male was often seen pecking, a not unexpected finding considering the greater bill length in the male. The larger-billed males are probably better adapted for pecking and feeding at the deeper levels of the bark and cambial layer. Compared to males, the female does less pecking and more gleaning. Presumably, the female with the smaller bill is less specialized for pecking.

Selander (1966) and Koplin (1967) found that the smaller sex in *Melanerpes* species and *Picoides tridactylus* foraged upon smaller substrates. We expected to find the smaller sex (female) of *M. superciliaris* foraging upon smaller substrates also (i.e., outer branches and higher up in the trees). The size difference between the sexes of *M. superciliaris* is statistically significant, and, therefore, should be great enough to have an effect on substrate selection. With the exception of the lower trunk, there were no statistically significant differences in the use of the zones, although females used the upper trunk and inner branches more than the males.

Differences in the foraging heights were statistically significant, with the males foraging higher than the females. These differences were more apparent when the sexes were feeding together in the same tree. Males of *M. superciliaris* are larger and presumably dominant to the females. Accordingly, the male should use this presumed advantage (dominance) when feeding together to forage in the more productive portions of the tree with the females giving way and feeding in the less desirable areas. On Grand Cayman, the more productive sites were the inner and outer branches where fruits, bromeliads, and many dead branches were located. The trunk (lower portions) was suboptimal in this respect.

The most frequently cited presumed advantages for intersexual foraging differences in woodpeckers are a reduction in intraspecific competition for food and a concomitant reduction in intersexual aggression (Selander 1966, Ligon 1968a, Wallace 1974, Hogstad 1976, Jackson 1979, Hooper and Lennartz 1981). These adaptive advantages may also be of major significance to *M. superciliaris* in their daily activities; pairs were often seen in close proximity maintaining contact vocally, and in some instances were observed feeding in the same tree. As suggested by Wallace (1974) and Hooper and Lennartz (1981) for other species, sexual partitioning of the foraging resource is a possible mechanism for facilitating social organization of *M. superciliaris* by reducing intersexual aggression and competition. It is interesting to note that Wallace (1974) found a positive correlation between foraging proximity and sexual dimorphism in bill length in several melanerpine woodpeckers. The strong correlation, also observed in this study for *M. superciliaris*, may be associated with foraging association of the sexes by permitting a finer division of the feeding niche.

The observations presented here suggest that male and female *M. superciliaris* on Grand Cayman Island differ in some types of feeding behaviors and may in this manner make more effective use of their environment. As pointed out by Kilham (1965), Selander (1966), Ligon (1968a), and Koch et al. (1970), however, regional differences in intraspecific foraging ecology may be expected among species with wide geographic ranges (e.g., Hairy Woodpecker [*Picoides villosus*], Red-cockaded Woodpecker [*P. borealis*], and White-headed Woodpecker [*P. albolarvatus*]). This is also probably the case for *M. superciliaris*, which occurs in different islands with a diversity of habitats present. In the Bahamas, for example, *M. superciliaris* also occurs in pine habitats, areas not present in Grand Cayman. Such regional differences in intraspecific foraging behavior may also be due to other factors including the quantity and quality of food available, sets of avian and other competitors, climatic factors, etc. Additionally, such studies as noted by Kilham (1965), Wallace (1974), Conner (1979), and Winkler (1979) must allow for effects of seasonal changes in popu-

lations of both predator and prey species as well as in those of competitors. In Hispaniola, Wallace (1974) found greater sexual differences in foraging in the dry winter months, considered to be a time of low food abundance. Less sexual difference in foraging mode was found in this species in ecologically more complex areas.

The large and diverse numbers of animal and plant species eaten strongly suggest that *M. superciliaris* is exceedingly diverse and opportunistic in its feeding habits, taking nearly all the animal and fruit material (within a certain size range) that it encounters while foraging. Fruit size is probably not of great importance, as the woodpecker uses its tongue and bill to feed on the fleshy pulp of large fruits. The generalist food habits of *M. superciliaris* are not surprising when one considers the following. Three broad ecological types may be recognized among North American woodpeckers (Bock 1970), each centering on a type of food niche. The first group, the "ground type," is represented by the flickers. Second is a group of "classical" woodpeckers (*Dendrocopos*, *Picoides*, *Dryocopus*, and *Campyphilus*), consisting of species that obtain their food largely by pecking and scaling living or dead wood to extract insect prey. Finally, relatively omnivorous species (in *Melanerpes*) are opportunistic in their feeding habits and obtain a majority of their food by non-pecking means. The opportunistic feeding habits of this species, the sexual difference, and the partial intersexual differences in the feeding niche found in *M. superciliaris* may perhaps be considered as being one of several adaptations in this Caribbean species which enables it to occupy a diverse number of habitats.

SUMMARY

The West Indian Red-bellied Woodpecker (*Melanerpes superciliaris*) is resident throughout Grand Cayman in suitable habitats from mangrove to dense limestone forests. Despite the overlapping ranges found for weight, culmen, and tarsometatarsal length, mean values were significantly higher in males than in females. When the differences found in those characters that are important for feeding (e.g., bill size) in *M. superciliaris* are compared with the intersexual differences in foraging behavior, a relationship between dimorphism and feeding niches seems evident. The predominant foraging methods are fruit-eating (37.7%), gleaning (23.9%), probing (20.6%), and pecking (13.4%). Compared with the female, the male was often seen pecking. The larger-billed males are probably better adapted for pecking and feeding in the deeper levels of the bark and cambial layer. The intersexual differences in gleaning were statistically significant, the females gleaning more frequently. We expected to find the smaller female foraging upon smaller substrata (i.e., outer branches and higher up in trees). With the exception of the lower trunk, there were no statistical differences in the use of zones, although the females also tended to use the upper trunk and inner branches with a greater frequency than the males. There were significant differences in the foraging heights, with the males foraging higher. In their daily activities, pairs of *M. superciliaris* were often seen in close proximity, maintaining contact vocally. Sexual partitioning of the

foraging resources is a possible mechanism of facilitating social organization in *M. supercilialis* by reducing intersexual aggression and competition.

ACKNOWLEDGMENTS

We acknowledge gratefully the support of the American Philosophical Society (Johnson Fund, Penrose Fund), the Bradley Fisk Fund, Frank M. Chapman Fund of the American Museum of Natural History, and a Biomedical Institutional Support Grant from the Division of Sponsored Research of the University of Florida.

LITERATURE CITED

- ALLEN, G. M. 1905. Summer birds in the Bahamas. *Auk* 22:113-133.
- AUSTIN, G. T. 1976. Sexual and seasonal differences in foraging of Ladder-backed Woodpeckers. *Condor* 78:317-323.
- BANGS, O. AND W. R. ZAPPEY. 1905. Birds of the Isle of Pines. *Am. Nat.* 39:179-215.
- BARBOUR, T. 1923. The birds of Cuba. *Mem. Nuttall. Orn. Club*, No. 6. Cambridge, Massachusetts.
- BOCK, C. E. 1970. The ecology and behavior of the Lewis Woodpecker (*Asyndesmus lewis*). *Univ. Calif. Publ. Zool.* 92:1-91.
- BOND, J. 1956. Checklist of birds in the West Indies, 4th Ed. *Acad. Nat. Sci.*, Philadelphia, Pennsylvania.
- BRUDENELL-BRUCE, P. G. C. 1975. The birds of the Bahamas. Taplinger Publishing Co., New York, New York.
- CODY, M. L. 1974. Competition and the structure of bird communities. Princeton Univ. Press, Princeton, New Jersey.
- CONNOR, R. H. 1979. Seasonal changes in woodpecker foraging methods: strategies for winter survival. Pp. 95-105 in *The Role of Insectivorous Birds in Forest Ecosystems* (J. G. Dickson et al., eds.). Academic Press, New York, New York.
- CRUZ, A. 1974. Distribution, probable evolution, and fossil record of West Indian Woodpeckers (Picidae). *Carib. J. Sci.* 14:183-188.
- . 1977. Ecology and behavior of the Jamaican Woodpecker. *Bull. Florida State Museum, Biol. Sci.* 22:149-204.
- AND D. W. JOHNSTON. 1979. Occurrence and feeding ecology of the Common Flicker on Grand Cayman Island. *Condor* 81:370-375.
- DUNN, G. AND B. S. EVERITT. 1982. An introduction to numerical taxonomy. Cambridge Univ. Press, Cambridge, England.
- GARRIDO, O. H. AND F. GARCIA MONTAÑA. 1975. *Catálogo de las Aves de Cuba*. Inst. de Zool., Acade. de Ciencias de Cuba, Havana, Cuba.
- GUNDLACH, J. 1893. *Ornitología Cubana*. Imprenta La Moderna, Habana, Cuba.
- HOGSTAD, O. 1976. Sexual dimorphism and divergence in winter foraging behavior of Three-toed Woodpeckers *Picoides tridactylus*. *Ibis* 118:41-49.
- . 1978. Sexual dimorphism in relation to winter foraging and territorial behavior of the Three-toed Woodpecker *Picoides tridactylus* and three *Dendrocopos* species. *Ibis* 120:198-203.
- HOOPER, R. G. AND M. R. LENNARTZ. 1981. Foraging behavior of the Red-cockaded Woodpecker in South Carolina. *Auk* 98:321-334.
- JACKSON, J. A. 1970. A quantitative study of the foraging ecology of Downy Woodpeckers. *Ecology* 51:318-323.

- JENKINS, J. M. 1979. Foraging behavior of male and female Nuttall Woodpeckers. *Auk* 96:418-420.
- JOHNSTON, D. W. 1970. Niche relationships in some West Indian Woodpeckers. *Year Book of the Am. Phil. Soc.* 1970:323-324.
- . 1975. Ecological analysis of the Cayman Island avifauna. *Bull. Florida State Mus., Biol. Sci.* 19:235-300.
- KILHAM, L. 1965. Differences in feeding behavior of male and female Hairy Woodpeckers. *Wilson Bull.* 77:134-145.
- . 1970. Feeding behavior of Downy Woodpeckers. I. Preference for paper birches and sexual differences. *Auk* 87:544-556.
- KING, W. B. 1981. Endangered birds of the world. The ICBP bird red data book. Smithsonian Univ. Press, Washington, D.C.
- KISIEL, D. 1972. Foraging behavior of *Dendrocopos villosus* and *D. pubescens* in eastern New York State. *Condor* 74:393-398.
- KOCH, R. F., A. E. COURCHESNE, AND C. T. COLLINS. 1970. Sexual differences in foraging behavior of White-headed Woodpeckers. *Bull. Southern California Acad. Sci.* 69:60-64.
- KOPLIN, J. R. 1967. Predatory and energetic relations of woodpeckers to the Englemann spruce beetle. Ph.D. diss., Colorado State Univ., Fort Collins, Colorado.
- LIGON, D. 1968a. Sexual differences in foraging behavior in two species of *Dendrocopos* woodpeckers. *Auk* 85:203-215.
- . 1968b. Observations on Strickland's Woodpecker, *Dendrocopos stricklandi*. *Condor* 70:83-84.
- MACARTHUR, R. H. 1958. Population ecology of some warblers of northeastern coniferous forests. *Ecology* 39:599-619.
- MILLER, J. R. 1978. Notes on birds of San Salvador Island (Watling's), the Bahamas. *Auk* 95:218-287.
- PAULSON, D. R. 1966. New records of birds from the Bahama Islands. *Philadelphia Acad. Nat. Sci., Not. Nat. No.* 394:1-15.
- RAMEY, P. 1980. Seasonal, sexual, and geographical variation in the foraging ecology of Red-cockaded Woodpeckers (*Picoides borealis*). M.S. thesis, Mississippi State Univ., Mississippi State, Mississippi.
- RIDGWAY, R. 1914. The birds of North and Middle America. U.S. Natl. Mus. Bull. 50.
- RILEY, J. H. 1905. List of birds collected or observed during the Bahama expedition of the Geographical Society of Baltimore. *Auk* 22:349-360.
- SCHOENER, T. W. 1970. Nonsynchronous spatial overlap of lizards in patchy habitats. *Ecology* 51:408-418.
- SELANDER, R. K. 1966. Sexual dimorphism and differential niche utilization in birds. *Condor* 68:113-151.
- AND D. R. GILLER. 1963. Species limits in the woodpecker genus *Centurus* (aves). *Bull. Am. Mus. Nat. Hist.* 124:213-274.
- SHORT, L. L. 1970a. Reversed sexual dimorphism in tail length and foraging differences in woodpeckers. *Bird-Banding* 41:85-92.
- . 1970b. The habits and relationships of the Megallanic Woodpecker. *Wilson Bull.* 82:115-129.
- SPRING, L. W. 1965. Climbing and pecking adaptations in some North American woodpeckers. *Condor* 67:457-488.
- WALLACE, R. A. 1974. Ecological and social implications of sexual dimorphism in five melanerpine woodpeckers. *Condor* 76:238-248.

- WILLIAMS, J. B. 1980. Intersexual niche partitioning in Downy Woodpeckers. *Wilson Bull.* 92:439-451.
- WILLSON, M. F. 1971. A note of foraging overlap in winter birds of deciduous woods. *Condor* 73:480-481.
- WINKLER, H. 1979. Foraging ecology of Strickland's Woodpecker in Arizona. *Wilson Bull.* 91:244-254.
- DEPT. ENVIRONMENTAL, POPULATION AND ORGANISMIC BIOLOGY, BOX B-334, UNIV. COLORADO, BOULDER, COLORADO 80309 AND DEPT. BIOLOGY, GEORGE MASON UNIVERSITY, FAIRFAX, VIRGINIA 22030. ACCEPTED 15 JUNE 1984.

POSITION AVAILABLE

Ornithologist.—Applications are invited for the position of Assistant Curator in the Division of Birds of the Field Museum of Natural History. The position is a 12-month, full-time, career track appointment scheduled to begin summer 1985, involving both research and curatorial responsibilities. Applicants must have a Ph.D. with primary interest in, and commitment to, systematic ornithology in the broadest sense. Preference given to candidates with the ability to perform imaginative research, who can develop an active field program, and whose interests are suited to a research career amidst one of the world's leading systematic collections of birds. Other duties may include participation in exhibition and education functions of the museum. Salary dependent on qualifications and experience. Send curriculum vitae, description of research experience and plans, reprints of publications and letters from three referees by 21 December 1984 to: *Dr. James S. Ashe, Chairman, Search Committee, Department of Zoology, Field Museum of Natural History, Roosevelt Road at Lake Shore Drive, Chicago, Illinois 60605.* AN EQUAL OPPORTUNITY EMPLOYER.